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## ABSTRACT

The Cornell University (New York) Cornell Theory Center (CTC), a national center for high performance computing, has created the award-winning Math and Science Gateway for grades 9-12 resources from the World Wide Web, organized in a fashion familiar to both educators and students, with links to resources in the areas of mathematics, computing, biology, chemistry, the earth, the ocean, the environment, meteorology, health, medicine, engineering, astronomy, and physics. The section for secondary school teachers contains information on curriculum, software for the classroom, and Internet access in the schools. The Gateway is updated frequently, with new materials being added and outdated information removed. From this successful initiative, other gateways are being designed by high school teachers. Topics discussed include K-12 education at CTC; a description of the Gateway; awards, feedback, and usage; maintenance of the Gateway; and the companion Gateway in Arts and Social Sciences. URLs for related Web sites are listed. (Author/DLS)

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# Math and Science Gateway: A Successful Model for High School Educators and Students

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# Math and Science Gateway - A Successful Model for High School Educators and Students

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**Abstract:** The World Wide Web provides new opportunities for education over the Internet. The Cornell Theory Center, a national center for high performance computing, has created an award-winning Math and Science Gateway for grades 9-12 (<http://www.tc.cornell.edu/Edu/MathSciGateway/>). It is designed to present the best resources from the Web, organized in a fashion familiar to both educators and students. The Gateway is updated frequently, with new materials being added, and outdated information removed. From this successful initiative, other Gateways are being designed by high school teachers.

## Introduction

The explosion of the Internet and the expanding number of Web sites provide a vast amount of information for educators and students. It can be very difficult for those unfamiliar with navigating the Net to locate organized information about specific topics. The Cornell Theory Center (CTC) has created an award-winning Math and Science Gateway for high school educators and students (<http://www.tc.cornell.edu/Edu/MathSciGateway/>), which provides annotated links to excellent math and science sites. These are organized by familiar topics, such as biology, chemistry, the environment, health, and mathematics. The Gateway also includes an extensive section for educators, and it provides an excellent entry point for those new to the Web and its wealth of information.

## K-12 Education at CTC

For the past ten years, CTC has been a leader in developing and delivering high performance computing education. Because its audience is a national base of researchers, CTC has aggressively pursued online information delivery and most recently Web-based education. A variety of K-12 initiatives is included in our education program.

In 1989, CTC assumed the lead role in conducting the SuperQuest contest, a national high school competition designed to extend high performance computing to the high school level. Small student/teacher teams spent three weeks at a CTC summer institute, learning high performance computing techniques and working with Cornell faculty. Each winning school was given a workstation, which enabled the teams to continue their research. SuperQuest expanded in the following years and involved other partners and centers who offered similar summer institutes. A number of state and regional high school competitions have been developed from this successful model.

CTC sponsors Kids On Campus as part of our annual celebration of National Science and Technology Week. The purpose of this event is to increase computer awareness and scientific interest among local elementary school students. Children participate in numerous activities, including a hands-on session introducing them to the World Wide Web.

During 1995, we offered a series of workshops for K-12 educators and administrators. These workshops introduced them to the Internet and the Web. Included were talks describing resources for educators, and a hands-on lab in which participants explored the Web through the Math and Science Gateway. School groups may now request use of CTC's Training Facility to do training and hands-on exploration of the Internet and Web.

## Description of the Gateway

In late 1993, CTC staff attending the Supercomputing '93 conference spoke to many K-12 educators who were interested in the Web but who found it unnecessarily confusing to locate the kinds of resources they needed for themselves and their students. In particular, it was clear that there was a gap on the Web in the areas of high school math and science, although plenty of relevant information was available for the younger grades. From this gap was born the idea of the Math and Science Gateway. Six months were spent collecting hundreds of potential resources and prototyping the Gateway. From there, CTC staff culled the best of those sites, organized and annotated them, separated out the resources that would be exciting to educators but not of interest to students, and produced the Gateway. It was announced in February of 1995.

The Math and Science Gateway provides an easy starting point for locating science and mathematics resources on the Web. It is tailored to the needs of students in grades 9 through 12, with links to resources in the subject areas of mathematics, computing, biology, chemistry, the earth, the ocean, the environment, meteorology, health, medicine, engineering, astronomy, and physics. The section for secondary school educators contains information on curriculum, software for the classroom, and Internet access in the schools.

The Gateway is optimized for ease of use by students. The resources accessible from the subject-area pages were selected to be particularly usable by high school students. This meant doing several things in the process of creating the Gateway. First, it was important to annotate every link. A page with links to "Welcome to the Planets," "Views of the Solar System," and "The Nine Planets" is of no use without descriptions of the sites to let you know which of the three you would find most interesting. Second, sites with specific information were preferable to sites containing long lists of links, only a few of which would be useful. For example, a site containing an article titled "About Temperature" was included, whereas a (hypothetical) meteorological organization whose home page included links to its bylaws, hiring policies, and a few dozen links to information about weather would not have been. Third, sites whose content or style were targeted for a much younger audience were omitted, even when those sites were very well done. Finally, sites with a commercial slant were omitted.

Educators use the pages designed specifically for them in order to locate topics relevant to the classroom. For example, educators might find lesson plans, classroom activities, and curriculum databases, both for Internet-based and traditional education. There are links to discipline-specific resources, including articles, instructional activities, and inexpensive software for the classroom. Other resources for educators include information on how to contact educators at other schools to facilitate Internet-based collaborative projects for the students, how to get your school on line, summer programs, teachers' organizations, and electronic discussion lists. In addition, educators peruse the subject-area pages targeted for students, to explore the multitude of resources included there.

### **Awards, Feedback, and Usage**

The Gateway has received many compliments and comments, as well as awards and write-ups.

It was rated among the top 5% of all Internet sites by Point Survey in the Education / K-12 category, and has received a 3-star award from the McKinley group. It won the award of "Excellence" in the 1995-96 WWW Home Page Competition sponsored by the Lone Star Chapter of the Society for Technical Communication. It was listed in the "Best of comp.infosystems.www.announce" when it was announced in that newsgroup.

The Gateway has been described in articles in "Mathematics Teacher" (Doerr and Hecht, 1995) and in "American Scientist" (Mike May, 1995). It was included in lists of Web sites for educators in the London Times Educational Supplement and in the May/June 1996 "National Council of Teachers of Mathematics News Bulletin."

We have received much feedback indicating that the Gateway serves its purpose and fills its niche on the Web very well. In addition to numerous non-specific comments (e.g. "Love this site, thanks for creating it."), we've heard from students and educators using the Gateway in a variety of ways.

From February through June 1996, we included a questionnaire on the Gateway's home page to solicit more specific feedback. We received approximately 400 responses, about half from students and half from educators. Among our findings was that many Gateway users are relatively new to the Web, affirming our original feeling that new users needed a Gateway such as this to help them navigate the multitude of resources that exist on the Web.

We received dozens of questionnaires from 7th grade students in Tully, NY, prompting us to get in touch with their teacher to find out how they were using the Gateway. The teacher had incorporated the Gateway into the science curriculum, and the students were using class time to explore resources in biology, health, chemistry, and the environment.

A math teacher from Ohio wrote, "I intend to recommend this to my Advanced Math/AP Calculus students in working on class reports and investigations, and for the researching of an annual term paper (topics such as the Golden Ratio, Fibonacci Sequence, Fractals, and Cryptology)."

Other teachers are using the Gateway to find resources to enhance the curriculum for basic and advanced science classes, to improve teachers' abilities in the classroom, and as a way to introduce both educators and students to the Web. Students have told us that it's useful in their research and that it helps with homework assignments; here are a few of their comments:

- "I use the Gateway to find out more about different mathematicians." (10th grade)
- "I'm in a Co-op researching information for teachers to use for their classes. These links have been a great help to me. Thanks." (12th grade)
- [How the student uses the Gateway] "To study for an upcoming test." (9th grade)
- "This helps me find what I want in sciences and helps me improve my math and science skills." (10th grade)

The Gateway has averaged close to 15,000 hits per month. Most of the subject-area pages get 200-400 hits per month, except for the math page, which averages about 2000. We have attempted to determine why this one page is so much more popular than the others, and have concluded that there are more collections of high school math resources on the Web than for other subject areas. Many of these collections link to the Gateway or directly to its math page. We can only surmise that mathematics educators have unusually high interest in using the Web.

### **Maintenance of the Gateway**

A Gateway such as this would quickly become obsolete if it weren't being updated regularly. CTC staff are on the constant lookout for new resources to add. In addition to perusing standard Web announcement lists, such as the newsgroup comp.infosystems.www.announce, Gleason Sackman's net-happenings listserv, and the weekly Scout Report, CTC solicits the help of local educators who keep us posted when they find relevant new Web resources.

We also receive unsolicited mail from our users, with their suggestions for additional resources. These are meticulously checked by CTC staff for their suitability. Roughly 80% of the suggestions to date have been added. The other 20% are mainly sites that are designed for a different age group (elementary school students, college students), sites that are too commercial, and sites that have too little educational content.

Knowing how frustrating it is to find broken links, CTC staff manually check each and every link in the Gateway every few months. The advantage of having a person doing this rather than a program is that we can catch URLs whose content has changed and are no longer appropriate, as well as those which have moved and left a "forwarding note" behind.

With the Gateway less than two years old, it hasn't yet grown too large. However, with the rapidly increasing number of Web resources, the Gateway has the potential of expanding to the point where it will be difficult to navigate. So far, rather than deleting some resources when we add new ones, we've

made an effort to keep it organized by creating new subcategories when necessary.

## **From One Gateway, Another is Born**

CTC has used the Gateway as a home page for educators and students attending Internet workshops. During the first of these workshops, in March of 1995, two local school librarians approached us and expressed interest in creating a companion Gateway in Arts and Social Sciences. With CTC's assistance, they completed that project later in the year. The two Gateways now include links to each other, and the pages for educators have been expanded to include additional resources of interest to educators outside of math and science.

## **Summary**

A Gateway optimized for ease of use is essential for those being introduced to the wealth of information available on the Web. Organizing the Gateway by familiar subject areas proved to be user friendly. Maintenance of the Gateway is also critical, because new Web resources appear daily. This approach has been very successful, and has provided a model for the creation of gateways in other subject areas.

## **Summary of URLs**

CTC Math and Science Gateway - <http://www.tc.cornell.edu/Edu/MathSciGateway/>  
 CTC Arts and Social Sciences Gateway - <http://www.tc.cornell.edu/Edu/ArtSocGateway/>  
 CTC Kids on Campus Web Demonstration - <http://www.tc.cornell.edu/Kids.on.Campus/WWWDemo/>  
 CTC Education Programs - <http://www.tc.cornell.edu/Edu/>  
 CTC Home Page - <http://www.tc.cornell.edu/>

Welcome to the Planets - <http://pds.jpl.nasa.gov/planets/>  
 Views of the Solar System - <http://bang.lanl.gov/solarsys/>  
 The Nine Planets - <http://seds.lpl.arizona.edu/nineplanets/nineplanets/>  
 About Temperature - <http://www.unidata.ucar.edu/staff/blynds/tmp.html>

Net Scout Services (The Scout Report and Net-Happenings) - <http://rs.internic.net/scout/>  
 Point Survey - <http://www.pointcom.com/>  
 The McKinley Group - <http://www.mckinley.com/>  
 STC, Lone Star Chapter - <http://stc.org/region5/lsc/www/ipic/wwwenter.html>  
 Best of comp.infosystems.www.announce - <http://www.boutell.com/announce/index.html>

## **References**

[Doerr and Hecht, 1995]. Doerr, Helen, and Hecht, Caroline (November, 1995). "Technology Tips: Navigating the Web," *Mathematics Teacher* 88, no. 8, pages 716-719.

[Mike May, 1995]. May, Mike (November-December, 1995). "Scientific Surfing for Children," *American Scientist* 83, pages 568-571. This is also available at URL <http://www.ams.org/amsci/articles/articles-MMay.html>

## **Acknowledgments**

Kathy Barbieri developed the concept of the Gateway based on her experiences at Supercomputing '93 and worked with Tony Gonzalez-Walker to develop the initial prototype. Caroline Hecht created the current version of the Gateway and continues to maintain it. Helen Doerr provided guidance and support throughout.

The Cornell Theory Center Arts & Social Sciences Gateway was conceived of and created by two school librarians in the Ithaca area: Jo-Ann Mancini, librarian at Lansing High School, and Barbara Nosanchuk, librarian at Cayuga Heights Elementary School; they received help from Caroline Hecht, in the CTC Online Information Group.



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